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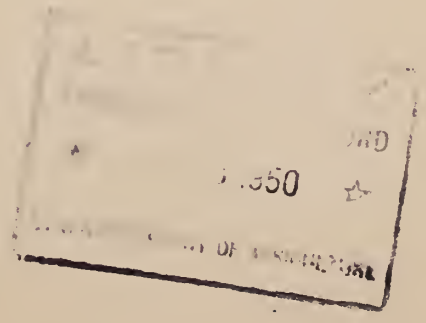
MAPLE SIRUP. I. RESEARCH PROGRAM ON MAPLE PRODUCTS AT THE EASTERN REGIONAL RESEARCH LABORATORY

C. O. Willits and W. L. Porter



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MAPLE SIRUP. I. RESEARCH PROGRAM ON MAPLE PRODUCTS AT THE EASTERN REGIONAL RESEARCH LABORATORY[1]

C. O. Willits and W. L. Porter

Introduction

The maple products industry is one of the oldest of farm enterprises in this country, and is unique in many respects. Maple sap is the only agricultural commodity which must be processed on the farm before it is saleable. Very little scientific work has been done to benefit the industry, particularly along the lines of improvement in quality and uniformity, and development of improved processing methods. Recognizing the need for chemical and technological research on this commodity the Department of Agriculture has established a research program at its Eastern Regional Research Laboratory, under the Research and Marketing Act of 1946, having as its objectives improvement in the quality and flavor of maple products, improvement of processing methods, and development of new and extended uses for maple products.

The purpose of the present publication is to present a brief review of the historical and economic background of the maple products industry, to discuss some of its technological problems, and to outline the research now in progress at the Eastern Regional Research Laboratory.

Historical and Economic Background

Maple products, comprising sirup and the several forms of sugar, candies, and maple cream, are made from the sap of the hard maple tree (*Acer saccharum*), the black maple (*Acer nigrum*) and the red maple (*Acer rubrum*). This is entirely a North American industry. The hard maple, which is the most important source, grows from North Carolina and Missouri north to the Great Lakes and in a small area in southern Quebec. The commercial maple area of the United States is much more restrictive, because of climatic conditions which influence the amounts of maple sirup and sugar made. This area extends westward from New England to Minnesota and southward to Kentucky. Here are found the ten states listed by the Bureau of Agricultural Economics[2] as producing a major part of the maple crop.

Maple sirup is not a major agricultural commodity in any of these states, but in each there are areas where it is an important part of the economy. In 1944 more than 565,000 pounds of maple sugar and 2,612,000 gallons of sirup were made, representing a cash crop of more than 8 million dollars

In 1944 and previous years the bulk of the crop was sold to the wholesale trade. This portion of the crop was divided almost equally between sirup reprocessed for table use and sirup used by the tobacco industry. In 1947

[1] Report of a study made under the Research and Marketing Act of 1946.

[2] Crop Reporting Board. Bur. Agr. Econ., U. S. D. A. page 25. Crop Report as of May 1, 1948.

maple sirup brought six to nine dollars a gallon, the highest in the history of the industry. Since 60 to 70 percent of that crop was sold on the retail market, no accurate record of its total value is available.

Vermont and New York are by far the largest producers and together they account for more than 70 percent of the total crop. In the past few years a relocation of the industry has been occurring as shown by sales of maple producing equipment. The majority of these sales have been in Ohio and other states to the westward rather than in New York and Vermont. This indicates that in these states either more trees are being tapped or there has been a movement to improve the equipment so that better maple products can be produced.

Maple products are a woodland or forest crop and so the industry is located in wooded areas often found in mountain or hill country. Here, because the amount of tillable land is limited, the maple crop is at times the important cash crop. The production of maple products takes place between February 1 and May 1, depending upon the location and weather conditions, a period when most other farm activities are at their slowest and so it provides a source of income during the slack period. This income may vary from a small to an appreciable part of the farm income and often represents a fraction which, if lost, may eventually spell success or failure to the farm. The actual income derived from this source is difficult to estimate, since the season, type of equipment, cost of labor, fuel used, and so forth, are variable from farm to farm and from year to year. However, a measure of the profit of this enterprise to the farmer is his hourly income. Professor J. A. Cope of Cornell University conducted a survey of 20 maple producing farms in 1947. This survey indicated for the farmer an hourly income for his labor of $0.56 to $3.78, with an average income of $2.08, which included the time spent on all operations such as the cleaning of the buckets and tapping the trees. These income figures[3] were based upon a sirup price of $4.78 per gallon. In Ohio, according to H. R. Moore and co-workers[4], the producers earned $2.11 per hour while making sirup, or 49 percent of the price received per gallon of sirup. The fixed costs for equipment, trees and buildings accounted for 51 percent of the price received.

Maple sirup and other maple products stand out as the most unique of all American agricultural products. Maple sap is the only farm commodity that is unmarketable; it must first be processed on the farm to convert it to sirup or some other useful form before it can be sold. Even so it is one of America's oldest industries and the earliest explorers found the Indians making sugar from the sap of maple trees for their own use and producing it in quantity for trade. References to maple sirup are to be found in the literature as far back as 1634. Typical of these[5] is a letter written in 1648 to a Mr. Ray by a Doctor Robinson. "I have enclosed you some sugar of the first boiling got from the juice of the wounded maple. Mr. Ashton,

[3] A. Dewey Bond, New York State College of Agriculture, Ithaca, N. Y. AE. 661 February 1948.

[4] H. R. Moore, R. H. Baker, and O. D. Diller. Ohio Agricultural Experiment Station. Bimonthly Bulletin, pp. 40 45 (Mar. Apr. 1948).

[5] H. A. Schuette and Sybil C. Schuette. Trans. Wis. Acad. Sciences, Arts and Letters 29: 209 236 (1935).

Secretary to the Royal Society, presented it to me. It was sent from Canada where the natives prepare it from said juice; eight pints yielding commonly a pound of sugar. The Indians have practiced it time out of mind; the French began to refine it; and turn it to much advantage."

Perhaps it is this history of the industry, wrapped so securely in backwoods romance, which has caused us to associate the production of maple sirup with old-fashioned methods. It would be almost an act of heresy to suggest to the American public that maple products can be produced and processed under present-day efficient streamlined methods. But, whatever the causes, the methods of processing maple sap to sirup and to other products are very much the same as they were 50 to 100 years ago, from the tapping of the trees, collection of the sap, and the use of open pan evaporators. It is only recently that researches have been instituted to discover ways in which these could be improved Most of the earlier work dealt not so much with improvements of processing methods and equipment but rather with means of protection through the detection of adulteration. These protective measures were and are today justifiable, since without them unscrupulous persons are tempted by the high prices to practice adulteration which could cause the American public to lose this prized food and in addition lose for the farmer a substantial income.

Maple Sirup and Maple Flavor

Maple sap, as it flows from the tree, is water white in appearance and has a slight sweet taste. It does not, as is commonly believed, contain any maple flavor. Instead it contains certain materials which under the proper conditions react to yield maple flavor This has now been conclusively proven by investigations here. This means that not only the flavor but also the amount of flavor developed in maple sirup is dependent upon the treatment given it from the time it drips from the tree until it is converted to sirup. Hence the methods employed in handling sap and in processing it to sirup will have to be reexamined from this point of view. To convert sap with its low sugar content to standard weight sirup a concentration of the sugar is effected by removal of large volumes of water. The enormity of this task is best understood when we consider that 85 gallons of water must be evaporated from a one percent sugar sap to produce one gallon of standard density sirup. The atmospheric evaporation of these large volumes of water is one of the most expensive of all industrial operations. There is a definite need for study on the development of more efficient processes and improved evaporators. The design of better equipment will not be an easy matter. Not only must the water be evaporated economically, but it must be done in such a manner as to favor the development of the maximum amount of flavor and to prevent its destruction. Further it must not cause the development of other flavors which could either mask or detract from the maple flavor.

Unlike most raw farm products, it is impractical to transport maple sap to commercial processing plants because of the costs in handling the large weights of water involved and because of its perishability through bacteriological spoilage. Any new equipment which will be developed as a result of

these studies must be simple and cheap so as to permit its use on the farm where it will be needed only a few weeks out of the year. It is conceivable that only a partial concentration will need to be effected on the farm and the process completed in a centrally located commercial concentration plant. This plan in part was tried in Antigo, Wisconsin[6] but the results were not conclusive. However, actual costs of this method may be prohibitive unless the evaporating unit employed is part of an existing industry.

In the past, due to factors beyond the control of the maple producer, it has not been possible to make exclusively one grade of sirup. As a result the retail trade has been supplied with a continually changing grade of sirup. One time it will be of a premium grade; another time it will be one of the lower grades. In 1948 some of our better producers, using the best equipment available, made all the grades of sirup from a fancy table sirup to a grade so poor it could not be classified. In 1949 so much fancy sirup was made in some sections that there was some difficulty in disposing of it. It is hoped that basic research will provide the means whereby a uniform product can be produced.

Maple sirup has always been a relatively high-priced luxury food; yet by ordinary chemical analysis it contains mostly water and sugar. The latter accounts for 95 percent of the solids; the other 5 percent is divided between invert sugar, ash and undetermined constituents. It is readily seen that maple sirup at several dollars per gallon containing only eight pounds of sugar will never compete with cane as a source of sucrose. The only justification then for the high price of this farm food product is its flavor, and it must be assumed, for the present at least, that the flavor is to be found in the one and one half percent solids still unaccounted for. Today very little is known about this fraction of the solids and still less is known about the identity of the flavoring material which it contains. Since the value of maple sirup and other maple products can be justified only upon its flavor, it must follow that a better knowledge of this flavoring substance will aid in improving the processing practices, the design of equipment, and the development of new uses of maple products.

Current Research Program

A successful research program must, therefore, be based upon a thorough knowledge of this maple flavor. This will require the identification of the flavoring material, a working knowledge of how it is developed, and a study of its chemical and physical properties. This will entail careful fundamental chemical research.

[6] Orval Polzin, Antigo Milk Products Cooperative, Antigo, Wisconsin. Private Communication.

Previous investigations[7,8,9,10] have indicated that maple flavor is present in sirup in only very minute amounts, perhaps only a few parts per million, which may explain why the problem has remained unsolved for so long. Fortunately during the last decade many new instruments and analytical techniques have been developed which will greatly assist in the studies leading to the isolation and the identification of the flavoring substance. Some of these include absorption spectrophotometry, X-ray analysis, polarography, chromatography, ion-exchange techniques, countercurrent extraction, and others.

About the time our investigations were undertaken a paper by Barnes and Kauffman[11] reported that they had succeeded in producing a substance which resembled maple flavor. This they had done by pyrolyzing a mixture containing a simple sugar and an amino acid, an adaptation of a chemical reaction which had been reported many years before by the French chemist L. C. Maillard[12]. It is only recently that it has been realized that this reaction is often the cause of the development of many of the natural flavors and of their accompanying brown color. Typical of such a reaction is the browning of freshly cut peaches. This associated brown color has caused it to be known as the "browning" reaction.

Should it be assumed that the browning reaction is the cause of maple flavor, it would presuppose that sap as it comes from the tree contains no maple flavor. Instead it would contain substances which when caused to react would result in a new substance, or substances, that account for the flavor. Such a supposition required that it be proven whether or not maple sap is free of maple flavor. Work just completed here has now proved that such is the case and that it is possible to make a maple sirup free of both color and flavor. The results of this work will be reported in a later publication. It was also necessary to know the optimum conditions of temperature, time of heating, and concentration of the sap for the browning reaction to occur. In conducting these investigations it was found possible to develop four to six times the flavor found in an ordinary sirup[13].

The production of this high-flavored sirup has provided further evidence that maple flavor is the result of a browning reaction. It still remains necessary to identify the mechanism and the chemical substances involved in this reaction. Maple sap is being fractionated into its various components of organic acids, amino acids, proteins, sugars and the like by means of ion-exchange techniques. After finding which of these fractions combine to

[7] Elphège Bois, Louis Charles Dugal. Naturaliste Canadian, *68:* 209 215 (1941).

[8] Elphège Bois, Louis Charles Dugal, and Maurice Lessard. Naturaliste Canadian. *69:* 5 10 (1942).

[9] J. Risi and A. Labrie. Can J. Res. *13B:* 175-184 (1935).

[10] Skazin and Snell. M. S. Thesis, McGill Univ., Nat. Res. Council. Report of Pres. (1928-1929).

[11] H. M. Barnes and C. W. Kauffman. Ind. Eng. Chem. *39:* 1167 (1947).

[12] L. C. Maillard. Academie des Sciences pp. 66-88 (1912).

[13] C. O. Willits and W. L. Porter, U S. Dept. of Agric. (Eastern Regional Research Laboratory) AIC-269, April 1950 (Processed). Maple Sirup II. A New High Flavored Maple Sirup.

produce the flavor, an attempt will be made to identify the active chemical constituents of these fractions. This is not an easy task because of the minute amounts of substances involved. For example, the amino acids must be separated from the nitrogen-containing fraction which is only 0.012% by weight of the sirup.

Another problem in the processing of sap to sirup to receive attention will be the development of more satisfactory means to determine when the sirup end-product has reached standard density in a continuous evaporator, and designing the equipment so that finished sirup can be withdrawn from it continuously. Among the many other problems considered will be the development of an instrument for accurately measuring the density of sirup either hot or cold; recommendations for methods of packing cold and hot sirup; and development of a simple chemical test for invert sugar so that the proper sirups can be selected for maple cream and candy making.

Recently permanent glass standards for color grading of maple sirup have been devised at this Laboratory[14]. A simple comparator containing these permanent standards is available commercially for the 1950 maple season. This work was done in cooperation with the Processed Products Standardization and Inspection Division of the Production and Marketing Administration and involved consultation with the New York Department of Agriculture and Markets and the Vermont Department of Agriculture.

[14] B. A. Brice, A. Turner, Jr., F. L. Southerland, and E. P. Bostwick. U. S. Dept. of Agric. (Eastern Regional Research Laboratory) AIC-260, February 1950 (Processed), 'Permanent Glass Color Standards for Maple Sirup.'

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